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Physical and mechanical properties of thermo-mechanically densified Poplar

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Introduction

Poplars play an important role in the plantation forestry in Hungary. Nowadays the share of poplars in the afforestations amounts to ca. 30%, the fellings come to 1 Million m^3/year. However the utilisation of poplar timber shows many difficulties. Possible outbreak could be the production of furniture (e.g. fronts) and other interior products (e.g. parquet). Unfavourable properties of poplar, such as low strength and stiffness, low durability, inexpressive colour and texture are a clear hindrance for widespread utilisation of the material in the furniture industry.

In order to surmount the obstacles we focussed our research work to enhance the relevant physical, mechanical and aesthetical properties of poplar (*Populus euramericana* cv. Pannonia) wood. The specific aim of our work was to establish the scientific background for a thermo-mechanical modification method. The process should enhance the surface hardness, the strength and the appearance of this low density wood with thin fibre walls. Thermo-mechanical densification schedules using different temperatures (160°C, 180°C, 200°C), densification grades (20%, 30%, 40%), and durations (15 min, 30 min, 45 min) were applied to poplar wood.

Conclusion

After the treatments the colour, the average density, the density profile, moisture related properties, modulus of rupture and the surface hardness were analysed.

The colour of the surface became more and more vivid by longer durations and higher temperatures. The well visible changes are reflected in the CIELab colour coordinate as it follows: Δa* (0 -+6), Δb* (+3 -+11), ΔL* (-2 - -22). The total colour change ΔE* reached values between 4 and 25 (Fig.1), thus the treatment caused well visible changes. The longer duration of the pressing treatment did not resulted in significantly higher total colour changes at 160°C and 180°C. The densification grade did not influence the colour change.

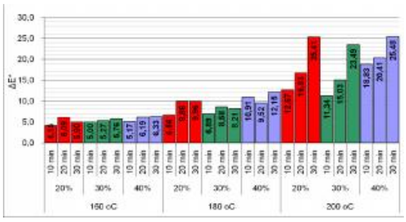

*Fig. 1: The effect of treatment parameters on ΔE**

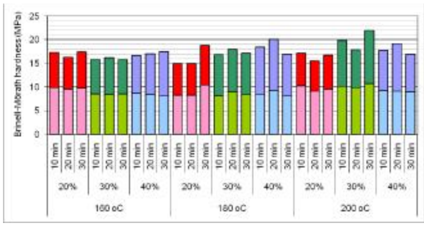

Fig. 2: The effect of treatment parameters on the Brinell-Mörath hardness

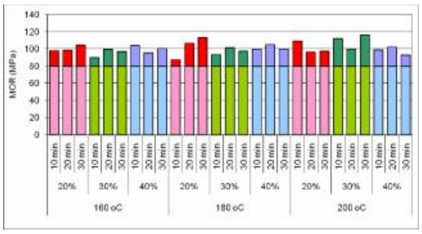

Fig. 3: The effect of treatment parameters on the MOR

A major positive result is the upgrading of the surface hardness, as the values could be raised by 60-130% (ca. 9 MPa for control and ca. 22 MPa for densified wood). Figure 2 shows a clear positive effect of the treatment in terms of hardness change. From the results we can conclude that the densification grade is the most prevailing among the treatment parameters. The treatments enhanced the MOR (Fig.3) and MOE (Fig.4) of the material. The MOE could be increased by 15-60%, and MOR by 10-45%. No clear influence could be proved for single treatment parameters (temperature, duration and densification grade). On Figure 2-3-4. light columns are before and dark columns are after the treatment respectively.

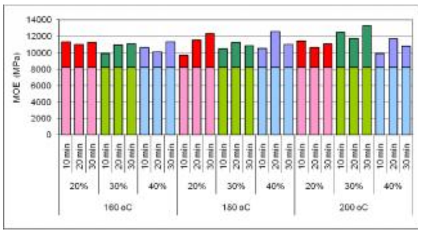

Fig. 4: The effect of treatment parameters on the MOE

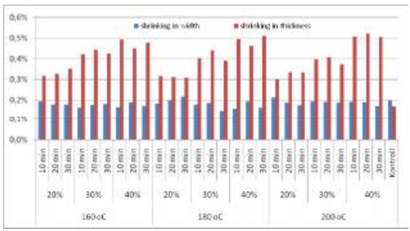

Fig. 5: The effect of treatment parameters on the shrinking coefficient in width and in thickness

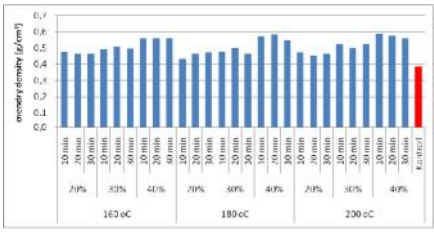

Fig. 6: The effect of treatment parameters on the ovendry density

The change of the density and the densification rate were the same (Fig.6) but the different densification rates caused different densities in the layers depending on the thickness. The density of the surface could be enhanced significantly, whilst the density in the core of the boards changed only in small extent (Fig.7). The higher densification rate resulted in higher swelling, but no clear influence of temperature and duration of densification could be proved (Fig.5). Because of the relative short treatment time, the thermal treatment modified the surface only, even at the highest temperature (200°C). Thus no thermal degradation occurred in the inner layers; therefore no water-related stabilisation effect could be aimed.

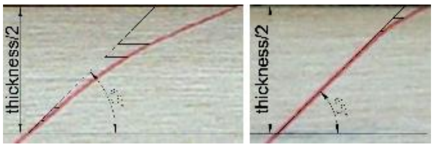

Fig. 7: The densification of different layers due to densification values of 40% (left) and 20% (right)

Further research is needed to enhance the water-related properties of the densified poplar wood. Different starting MCs and higher temperatures are subject for future investigations.

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